MODELING THE CROSS-MARGIN EXCHANGES AND INTERACTIONS BETWEEN COASTAL AND DEEP-OCEAN

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Award #: N00014-96-1-0937

LONG-TERM GOALS

The specific goals are toward the understanding of the physical mechanisms that control the shelf, shelf/break, and slope dynamics and the cross-margin interactions between the coastal and deep-ocean regions.

OBJECTIVES

- to evaluate whether a moderately parallel processing environment is suitable for ocean modeling applications;
- to investigate the feasibility of a two-way communication scheme between the large-scale basin and the high-resolution coastal models;
- to understand and model the interaction between the deep and shallow waters and the mechanisms through which the shelf and open ocean exchange mass and momentum;
- to understand and model the climatology and seasonal variability of the Mississippi Bight (MB) and determine the long-lasting structures as opposed to transitory features;
- to understand and quantify the relative importance of the transitory vs. the long-lasting features in the cross-margin transfers between the MB and the Gulf of Mexico (GOM).

APPROACH

The approach is to implement a modeling system that connects large-scale, basin-wide and high-resolution, coastal models. The Princeton Ocean Model is the model of choice for the development of a procedure in which modules, corresponding to the basin and coastal domains, are executed in parallel and communicate the coupling variables to each other. The

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1998		**00-00-1998 to 00-00-1998**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Modeling the Cross-margin Exchanges and Interactions Between Coastal and Deep-Ocean	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Southern Mississippi,Institute of Marine Sciences,Stennis Space Center,MS,39529**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002252.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**5**	

approach offers the benefit of modeling coastal environments, taking into account the mutual interactions between the shallow and deep waters, without the computational burden of configuring the basin domain at the high resolution required by coastal applications.

WORK COMPLETED

The two-way nesting procedure and the parallellization of the system has been completed. The coupled system is highly portable. C-preprocessor directives control whether the models are executed independently or in parallel, the choice of the communication algorithms and the message-passing libraries. The communications between the coarse and fine grids are based on the PVM and MPI message passing libraries. Currently, the simulations are executed on the Origin 2000 and Power Challenger platforms. A version with PVM software is available for the C-90 and Cray-YMP.

It is known that the σ-coordinates in the presence of steep topography may lead to errors and model instability. The effects on the pressure force terms are well documented (Haney,1991). Errors associated with the nonlinear and diffusion terms may also produce spurious heating/cooling in the temperature Eq., and equivalent forcings for the other variables (Martin et al., 1998). To prevent the model solution drift over extensive simulations, the constituent fields are nudged to climatlogy over a one year time scale. Current tests are evaluating the sensitivity of the nested model to the algorithm.

RESULTS

Intrusions of the Loop Current over the coastal areas have been analyzed as a function of several data sets:

- Bathymetry (ETOP05 and MMS-GOM101)
- Winds i) Hellerman-Rosentein monthly climatlogy, 2) MMS monthly climatology and 3) ECMWF-1993 6 hour winds.
- Temperature and salinity from Levitus and MMS climatology.

The MMS data sets have been developed by Dynalysis. ECMWF winds were acquired from the DAMEE-NAB data sets.

Fig. 1. illustrates an intrusion of the Loop Current over the MB domain. The model is initialized with the GOM101 bathymetry and forced by the ECMWF winds. Temperature and salinity are nudged to the MMS climatology. Under favorable wind conditions, warm-

water filaments detach from the Loop Current edge and move northward along the eastern side of the De Soto Canyon, approximately following the 100m isobath. At the western side of the canyon, the front is unstable and develops meanders, within which cold, coastal water intrudes. The cold filament of Fig. 1. eventually becomes a cold eddy that is carried away from the coast, contributing to the cross margin exchange between shallow and deep regions.

IMPACT/APPLICATIONS

This research addresses relevant issues for the Navy's operational activities on littoral regions. It provides:

- a modeling approach for the coastal areas that takes into account the mutual interactions between shallow and deep waters (i.e., physically accurate);
- a coupled system which is computationally efficient and higly portable (i.e., cost effective and easily reconfigured for other coastal regions);
- evaluation of whether moderately parallel environments are suitable for ocean applications (i.e., in line with the new computer technologies).

TRANSITIONS

This project provides a transition of knowledge and nesting techniques to be used in other coastal modeling applications. Data have also been transfer to the NRL-SSC acoustic group to test and evaluate 3-D acoustic models over coastal areas.

RELATED PROJECTS

This program fits well with the DoD High Performance Computing Modernization Office interests in developing scaleable (i.e., workstation clusters or multiprocessor platforms) ocean and atmospheric modeling applications.

Under the sponsorship of the MMS, a multi-year hydrographic survey program is in progress in the DeSoto Canyon area and Northeastern Gulf. At the University of Colorado, R. Leben is developing a nearly real-time database of TOPEX/ERS-2 altimetry data. Both programs provide a valuable set of data and measurements for our model initialization and model-data comparison.

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Temperature GOM101, ECMWF93

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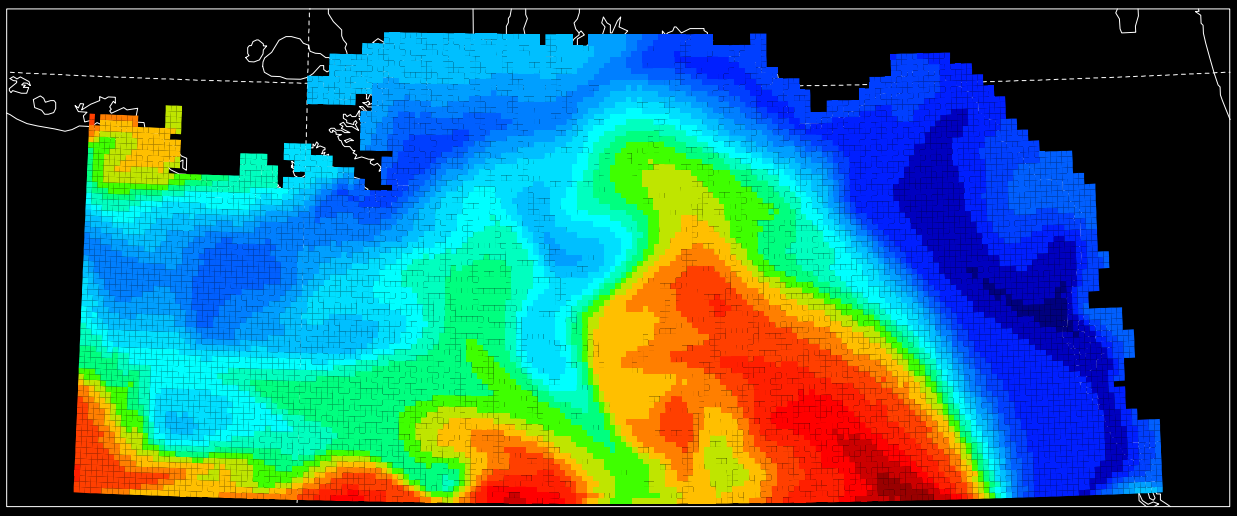

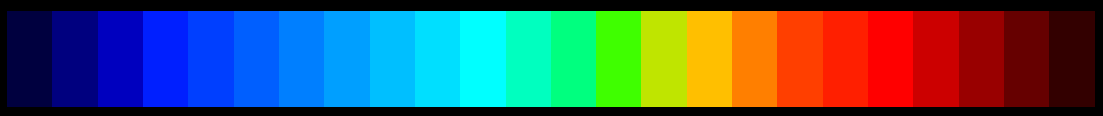

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